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AUTHOR Hollifield, John H.
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INSTITUTION Council for Educational Development and Research, Washington, D.C.
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ABSTRACT

A look at the potential impact of high technology suggests that there may be a dim side to the popular view that high technology is the answer to America's educational and occupational problems. In reality, as technology advances continue, required job skills will decrease further. High technology will account for only 7 percent of all new jobs created between 1980 and 1990, while managerial, professional, clerical, and service occupations will account for 68% of the employment growth during this period. Contrary to the usual assumption that increasing technology will allow machines to perform the more tedious and less skilled tasks, high technology will actually further simplify and routinize work tasks and reduce the need for worker individualization and judgment. Educators must resist the pressure to concentrate on specific skill training that will become useless as job requirements change. Instead, education should prepare students for success by providing skills in logic, analytical reasoning, scientific knowledge, communication, and the cultural arts. By providing these skills in addition to on-the-job training and recurrent education at various times over the life-cycle (as technology changes job requirements), schools can best utilize high technology as a tool for learning rather than as a subject that will displace more fundamental learning. (LH)

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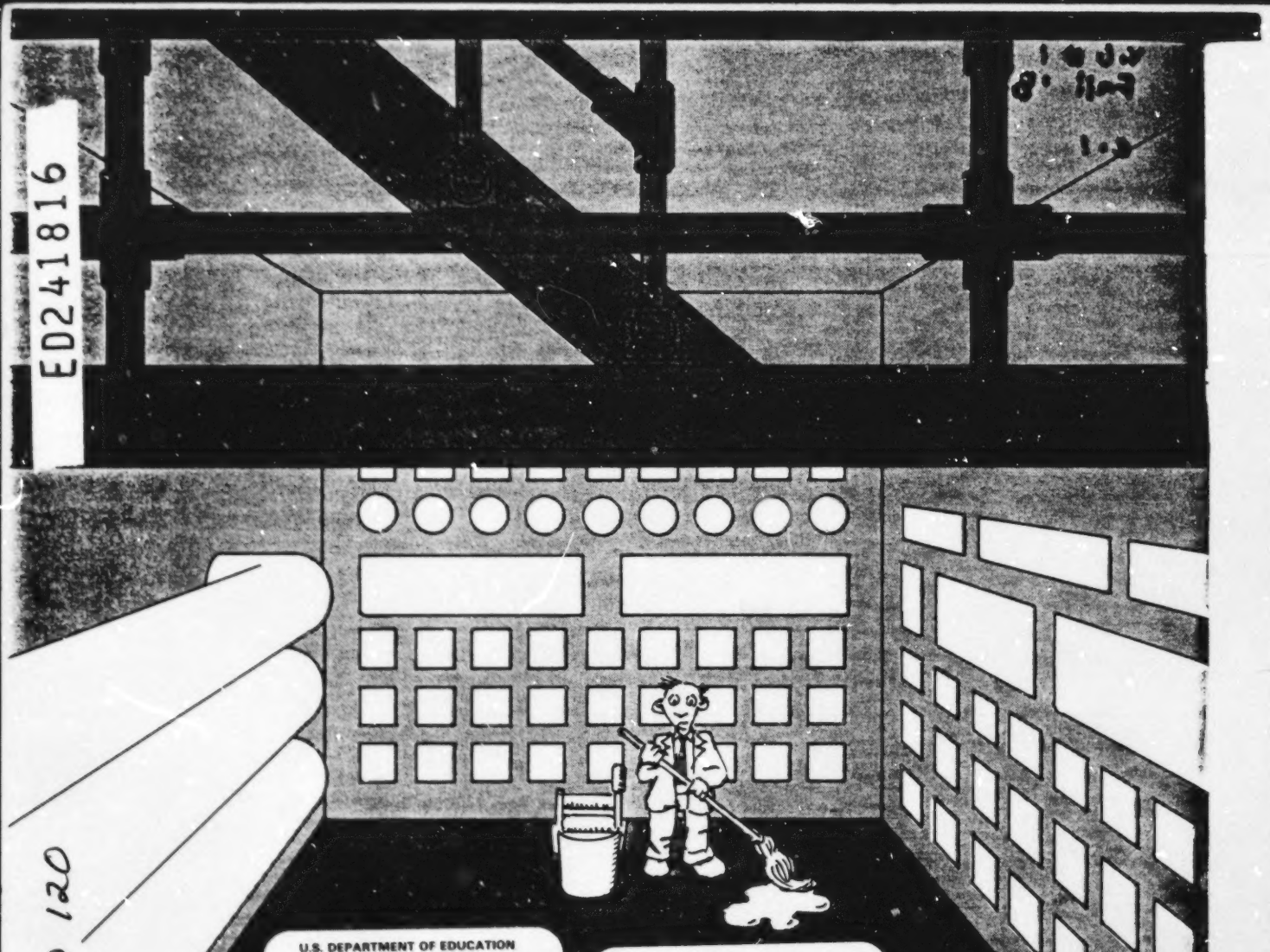

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

**You know what a player piano is. You put a coin in and it bangs out a tune.**

It doesn't require a piano player to tickle the ivories. It tickles its own ivories. And if it's programmed well, it tickles those ivories better than you or I ever could.

Kurt Vonnegut Jr.'s novel *Player Piano* —written over 30 years ago—uses this instrument to symbolize a dim view of America's high-tech future. In this future, an elite group of managers and engineers control our technological society. They're not a happy group, even though they're well paid, because they spend most of their time simply monitoring machines, which is not a challenging task.

But they're a lot better off than the rest of the people—those who are not managers or engineers—because all these people are useless, bored, discontent, living in a world where technology meets all their needs except the big one, the need to live a useful, productive life.

As I read Vonnegut's book, I became more and more uncomfortable. By the end of the book, my discomfort was close to depression. All my previous readings about the glamour and glory of the coming age of high technology stood contradicted, full of empty promises.

### Is This the Future?

And I understood why, when I had asked Hank Levin to tell me more about his work on the impact of high technology on America's educational and occupational future, he had referred me to Vonnegut's book. And my first question when I called Levin at the Institute for Research on Educational Finance and Governance at Stanford University, where he serves as director, could only be: "Do you think this is really what lies ahead in a high-tech future?

"It's where we're going," Levin asserts. "Based on our Institute's research, given the trends as they exist, given present-day attitudes—yes, we're moving toward a society in which most people work at unfulfilling low-level tasks or have no work at all while only a select few hold interesting, skilled positions.

"I'm not saying we're doomed, that this is inexorable. But if we sit back and do nothing to change the present course, the high-tech future isn't bright —it's frightening."

This view of the future runs counter to popular opinion, which sees high-tech as a glorious answer to many of our problems, not as a larger problem in itself. In the popular view, people will work mainly at high-tech jobs in a high-tech world, interacting with their machines and working with electronic terminals in almost all facets of their jobs. The purpose of the educational system will be to provide all students with the math and science expertise and computer literacy that they need to assume their rightful places in this society. Armed with these school-produced technical skills, they will accomplish exciting and purposeful work.

"This is not a realistic view," according to Hank Levin. "In the immediate future and thereafter, most new jobs will not be in high technology occupations. And the application of technology to existing jobs will not require a vast upgrading of skills in the labor force.

### Less Skills Needed

"Actually, growth of low-skilled jobs in the American economy will far outstrip the growth of high technology jobs. And the application of technology in current jobs is going to reduce the skills needed to perform those jobs."

Let's run through that one more time. Prevailing opinion is that future jobs will be mostly high-tech, requiring an extensive math, science and computer skills background, and requiring a labor force of highly skilled people.

But prevailing opinion is wrong, says Levin. Most future jobs will be low-skilled or middle-skilled positions, many existing jobs will disappear, and the existing jobs that survive will require lower levels of skill than they do now. And as technological advances continue, the required job skills will decrease further.

Let those words sink in. Think about the implications for our education system. Think about the courses we're currently advocating for schools to follow; think about how educators and parents are pushing students toward high-tech careers; think about all the students living with the fear that, unless they develop math and science and computer skills and develop them well, there's no future in society for them.

### What Will the New Jobs Be?

Levin and research associate Russell Rumberger have documented these opposing projections of the impact of technology, using the best available data from the Bureau of Labor Statistics of the U.S. Department of Labor.

"Employment will increase by 22 million, or about 23 percent, between 1978 and 1990," Levin and Rumberger project. "In percentage terms, many high-tech occupations will be increasing at a fast rate. Employment for data processing machine mechanics, computer systems analysts, and computer operators, for example, is projected to increase by over 100 percent.

"This rate of growth increase is what causes people to assume that future jobs will be high-tech and require highly skilled workers. But the total number of new jobs generated in these occupations will be much less than the total number of jobs generated in other areas. Of the 20 occupations expected to generate the most new jobs by 1990, not one is related to high technology. In fact, the five occupations that will grow the most are all low-skilled—janitors, nurses' aides, sales clerks, cashiers, and waiters and waitresses. These five categories alone will account for 13 percent of the total employment growth between now and 1990.

"And of the 'top 20' occupations that will contribute most to job growth, only two—teaching and nursing—require a college degree."

The numbers tell the story quite clearly, Levin and Rumberger point out. "Between now and 1990, only 20,000 new jobs for computer analysts will be created. In contrast, there will be 600,000 new jobs for janitors and sextons. About 140,000 new jobs for computer programmers will emerge, compared to 800,000 new jobs for fast food workers and kitchen helpers.

"In fact, estimates show that high technology occupations, as a group, will account for only seven percent of all new jobs created between 1980 and 1990."

The figures for employment growth by categories of work also favor low and middle level occupations. While employment in all managerial and professional occupations is projected to increase by 28 percent up to 1990, clerical and service occupations will account for 40 percent of the employment growth during this period.

"In short," they emphasize, "employment growth will occur primarily in jobs that require little or no training beyond the high school level. Although employment in high-tech occupations will show a high percentage increase over this decade, the actual number of these jobs compared to the total number of jobs available is really quite small."

**All, right, let's concede that high technology occupations will not provide the most opportunity for employment in the foreseeable future.**

But still, what about the effects of technology on existing jobs? Won't workers need more and more sophisticated skills as technology is applied to more and more existing jobs?

"Not at all," according to Levin and Rumberger. "Most jobs will require less sophisticated skills due to technological advances."

The usual assumption, they point out, is that increasing technology will allow machines to perform tedious and less-skilled tasks, while the most skilled and challenging tasks will continue to be performed by workers. Thus, as technological automation becomes more widespread, with more and more workers using complex and sophisticated machines, the workers will need increasingly complex skills.

"This assumption holds true for a short while only," the researchers say. "When automation is first initiated, higher job skills are needed. But as the degree of mechanization increases, the skill requirements of jobs decrease sharply.

"Again, statistics support this point of view. For example, wide-spread automation has taken place in many industries over the last two decades, but the aggregate skill requirements of jobs in the U. S. economy have changed little during that period."

But what drives the point home most effectively are case studies of the application of technology in actual work settings—and its application in the computer industry inself provides a prime example.

"Working with early computers required high programming and operating skills," Levin and Rumberger point out. "But as the technology advanced, the tasks and the skills involved became much less complex. Computer programming was soon divided into the more creative, skilled tasks—performed by the systems analysts—and the more tedious, routine tasks, performed by the programmers and coders. Programming itself became easier as technology produced more simple packaged programs.

"And further technological advances in computer software have enabled workers to use computers in a wide variety of work settings without any knowledge of computer languages. The new generation of office computers, for example, is designed to be used by people without any computer skills. Also, office computers perform many of the tasks previously done by secretaries, actually reducing the skills needed for doing office work."

### Just Push a Button

Other examples are abundant, Levin and Rumberger continue. Lawyers used to need strong research skills, so they could locate and examine past cases and pull out the relevant information that would make their current case a winner. Now, they simply do a quick computer search—or assign the job to a low-paid clerk—which requires entering some key topic words and pushing a few buttons. Television repairers always prided themselves on their ability to apply their diagnostic skills and experience to pinpoint a malfunction. Now they simply plug the set into electronic diagnostic equipment which tells them exactly what the problem is and even what to do about it—which usually means replacing a module. The point is, it takes little or no skill now to research a law case or repair a television set. And the same thing is occuring in almost any occupation you want to name.

"Computers and other products of the micro-electronics revolution are transforming work in almost all sectors of the economy," say Levin and Rumberger. "This transformation will become even more widespread as technologies become even more sophisticated. Machines will be able to perform more complex mental tasks as more advanced software is developed. But the use of this sophisticated equipment will not require workers with higher skills—past technological advances show us that the opposite is more often the case.

"So future high-tech will further simplify and routinize work tasks and reduce the need for worker individuality and judgment. Moreover, the displacement in jobs and the downgrading of skill requirements for most of the new positions will undermine employment in general, and especially the employment of skilled workers."

Levin and Rumberger note that retraining is advocated as the answer to helping the current workforce move "from smokestack to high-tech." But they caution that there are major negatives involved in retraining issues. One, of course, is the lack of enough high-tech jobs. Another is the problem of downward mobility.

"One of the success stories cited by retraining advocates concerns the steelworker in Pittsburgh who got help from President Reagan to be retrained," says Levin. "The man is now employed by Radio Shack. A real success story, right? Except for one thing—the man was making about $12.50 an hour as a steelworker, and now he's getting about $6.50 an hour in his new high-tech position.

"This is no isolated occurrence. It's downward mobility, a fact of life for a lot of people who are fortunate enough to get retrained so they can enter high-tech jobs. Well, retraining isn't going to allow them to enter the field at the top, where the salaries could match or exceed their previous earnings. Economically, they're moving down the ladder, even though the people who are unemployed and not retrained are still on the rungs below them."

**Educational Implications**

Right now, according to Levin, the emphasis on high-tech is doing some good things for education in general.

"Politically, high-tech is helping to focus attention on education. It's easy to pump up the importance of education by talking high-tech: by emphasizing how we need to produce highly skilled students who can meet the technical demands of this new world, by forecasting our demise as a nation unless we can provide the job market with workers who have the needed technical skills. To the extent that this pumping up produces an upgrading of curricula and teachers and the system in general, it's a good outcome.

"So I don't want to badmouth high-tech as a political issue. But if we're talking about being politically honest, and talking about how the education system can really help us not only deal with high-tech but maybe even help us avoid a dismal 'player piano' type of future, there are some things we should do.

"First, the prevailing attitude is that we need more specific, vocational high-tech training in the schools so that, after graduation, the students can move into the workforce and work with a machine to get a specific job accomplished. But this kind of overemphasis on specific training will put our students at the mercy of technology, not put them on top of it. Their specific training will be useless as job requirements change over time due to technological progress.

"The worse thing schools can do right now is concentrate of specific skills training."

But isn't this exactly wnat schools are being pressured to do—provide students with concentrated doses of technological training, primarily on and by using microcomputers?

"It is, but schools must resist the pressure," Levin and Rumberger declare.

"The purpose of education is not to provide specific technological training, especially when such training will quickly become obsolete and especially when most of the jobs that will be available will not be jobs that require high technical skills.

"This kind of training can best be handled in two ways—first, by on-the-job training that teaches the specific technical skills needed in the specific job that the person is in, and second, by recurrent education—retraining workers at various times over the life-cycle as changing technology changes the requirements of their jobs."

Levin and Rumberger are currently looking at the role of recurrent education in providing relevant technical training. The process will be demand-driven, Levin notes. The public schools can be involved if they can provide the up-to-date, technical and specific expertise that retraining requires. But companies will be looking to any organization that has the expertise—private technical training schools, community colleges, manufacturers' training facilities. Flexibility will be the key word. And the major problems will be coordinating all the activity and somehow financing it.

But if on-the-job training and recurrent education are the best avenues for providing workers with the specific technical skills they need in their careers, what is the role of the school in preparing students for the coming high-tech society?

As a preface to their answer, Levin and Rumberger remind us of the real purpose of education.

"There are three domains that education must address if it's to be most effective for all students. These are preparation for careers, preparation for citizenship, and preparation for areas other than work, such as leisure and consumption.

"And the best way schools can prepare students for success in all these domains is by providing skills in logic, analytical reasoning, scientific knowledge, and all sorts of communicative skills. That means emphasizing reading, writing, speaking, listening, interpretation of written and spoken material, and proficiency in one or more foreign languages."

This type of educational foundation meets the needs of all three domains, Levin and Rumberger state. It provides the skills required to both learn and perform in a changing work environment, and assures access to productive study at the postsecondary level or to entry-level jobs and careers with potential upward mobility. It provides the general scientific and technical background and the general skills required for analyzing and discussing citizenship issues. It prepares students to reason and to use information, which enables them to make wise consumer decisions.

"Add a cultural dimension, too," suggest Levin and Rumberger. "The schools should provide exposure to the fine arts, music, literature, integrating written and oral expression and discourse into these areas."

Look carefully at these recommendations. No mention is made of the narrow, vocational, technical-skills training that schools are under fire to provide. Nor is there an argument made for providing every student with computer terminal and programming experience.

"There's nothing wrong with using computers to help teach logic or assist in the learning of a variety of subjects," say Levin and Rumberger. "But let's keep the perspective where it belongs —

**The computer should be used as a tool for learning, not as a subject that will displace more fundamental learning"**